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Effect of Canola Oil on Saturated Fatty Acids Contents in Broiler Meat

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Abstract: This experiment was conducted to determine the effect of dietary Canola oil (unsaturated oil) of on breast and thigh meat Saturated Fatty Acids (SFA) percentage. A total of 90 Ross 308 strain were randomly divided into 3 experimental treatments with 3 replicates (10 chicks per pen) and arranged in a completely randomized design. The experimental period lasted 6 weeks and during this period, the birds had free access to feed and water. Experimental diets consisted of: Basal diet with 0% canola oil; basal diet with 2% canola oil and basal diet with 3% canola oil. These diets were isonitrogenous and isoenergetic were given to broiler chickens throughout a 42-d growth period. Meat fatty acids profiles with Gas Chromatography (GC) technique were measured. Data was analyzed with one way ANOVA and means compared with Duncan test. According to results Saturated Fatty Acids (SFA) for breast meat is significant ($p<0.05$) and from 37.37% reached to 35.94 and 31.76% for T2 and T3, respectively and for thigh meat not significantly difference but numerically decrease and from 36.65% for T1 (0% CO) reached to 33.94 and 34.73%, respectively for T2 and T3.

Key words: Broiler, canola oil, meat, SFA, effect

INTRODUCTION

Oils have commonly been used as energy sources in the diets for broiler chick's especially in grower and finisher periods. Studies have shown that type of dietary lipids of the broiler chicks, can drastically alter the fatty acids profile of meat (Balnave, 1970; Scaife *et al*., 1994; Hrdinka *et al*., 1996; Lo´pez-Ferrer *et al*., 1999a, b; Salamatdoust *et al*., 2007). Canola oil has been recognized as rich plant source of linolenic acid (C18:3), linolenic acid can be converted to longer chain omega-3 fatty acids, such as Eicosapentaenoic (EPA, C20:5), Docosapentaenoic (DPA, C22:5) and Docosahexaenoic (DHA, C22:6) acids in poultry through elongation and desaturation pathway, thus enriching the broiler meat with omega-3 fatty acids (Sim and Qi, 1995; Crespo and Esteve-Garcı´a, 2001, 2002a, b; Hrdinka *et al*., 1996). Omega-3 fatty acids have many health benefits including the ability to cardiovascular disease (Cherian and Sim, 1991; Grobas *et al*., 2001), antithrombic (Herod and Kinsella, 1986) and rheumatoid arthritis. Health recommendations have encouraged a reduction in the consumption of total lipids, saturated fatty acid and cholesterol but to increasing the proportion of mono unsaturated and Polyunsaturated Fatty Acids (PUFA) in human diets (Walsh *et al*., 1975; Temple, 1996; Grundy, 1980) found that dietary mono-unsaturated fatty acids (e.g., oleic acid) were very effective in lowering blood cholesterol concentration and may be important in preventing coronary heart disease. Also genetic, age and pharmacology agents are known to affect egg and meat cholesterol deposition (Hargis, 1988; Halle, 1996, 2001). The objective of this research was to determine the effects of feeding canola oil on blood cholesterol level and fatty acids composition of broiler chicks meat.

MATERIALS AND METHODS

Animals and diets: Experiment was conducted of the Ross 208 strain were obtained from a commercial hatchery (90, 1 day old male broiler chicks) and were placed in 9 floor pens of 2×2 m with 10 birds per pen. All chicks were fed a starter diet from 0-21 d and were *ad libitum* access to water and feed. The experimental design consisted in a completely randomized design with 3 treatments [T1 Control (Soybean +corn), T2 (2% CO) and T3 (4% CO)] with three replication. The treatments diets of were isonitrogenous and isoenergetic. Diets were formulated by adding 0, 2 and 4% canola oil to basal diet (corn and soybean meal) that met the requirements recommended by the National Research Council (1994). The control diet, which was not enriched with canola oil and was administered throughout the 21 days of experimental period (starter). The levels of canola oil were replaced with corn in diets during 2 different periods (grower and finisher). Ingredient composition and nutrient analysis for each treatment is described in Table 1-3. At the age of 8 week, all the birds were weighed before

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Table 1: Percentage composition of experimental diet in starter period

Ingredients	(%)
Corn	53.5
Soybean	34
Canola oil	0.5
Starch	8
Wheat bran	0
DL-Methionine	0.54
Lysine	0
DCP	1.38
Oyster	1.33
Vitamin[1]	0.25
Mineral[2]	0.25
Salt	0.25
Coccidiostat	0
Sand	0
	100
Calculated nutrient content	
ME kcal kg^{-1}	2920
Crude protein (%)	21
Calcium (%)	0.94
Available P (%)	0.43
ME/CP	139.7
Ca/P	2.1

1Vitamin content of diets provided per kilogram of diet: vitamin A,D, E and K.2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg

Table 2: Percentage composition of experimental diets in growth period

	Experimental diets		
Ingredients	T1[3]	T2	T3
Corn	64	60	55
Soybean	27.4	28	27.1
Canola oil	0	2	4
Starch	3.74	2.06	1.22
Wheat bran	1	2	5.5
DL-Methionine	0	0	0
Lysine	0	0	0
DCP	1.13	1.14	1.16
Oyster	1.5	1.48	1.46
Vitamin[1]	0.25	0.25	0.25
Mineral[2]	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Coccidiostat	0.15	0.15	0.15
Sand	0.33	2.42	3.66
	100	100	100
Calculated nutrient content			
ME kcal kg^{-1}	2920	2920	2920
Crude protein (%)	18.2	18.2	18.2
Calcium (%)	0.9	0.9	0.9
Available P (%)	0.35	0.35	0.35
ME/CP	160.1	160.8	160.7
Ca/P	2.5	2.5	2.5

1Vitamin content of diets provided per kilogram of diet: vitamin A, D, E and K. 2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg.3 T1 = 0%. 3 T1 = 0 % canola oil (CO); T2 = 2%CO; T3 = 4% CO

being slaughtered and then eviscerated. Weights air-chilled carcasses after cutting off their heads and feet and after removing abdominal fat (considered as the fat extending within the ischium, surrounding the cloaca and adjacent to the abdominal muscle) to obtain ready-to-cook carcasses were recorded.

Table 3: Percentage composition of experimental diets in finisher period

	Experimental diets		
Ingredients	T1[3]	T2	T3
Corn	66.5	57.5	56
Soybean	24.1	25.85	24
Canola oil	0	2	4
Starch	3.81	4.34	1.94
Wheat bran	0	5	6
DL-Methionine	0.44	0.45	0.45
Lysine	0.043	0.015	0.08
DCP	0.89	0.92	0.89
Oyster	1.38	1.36	1.31
Vitamin[1]	0.25	0.25	0.25
Mineral[2]	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Coccidiostat	0.15	0.15	0.15
Sand	1.937	1.665	4.43
	100	100	100
Calculated nutrient content			
ME kcal kg^{-1}	2920	2920	2920
Crude protein (%)	16.5	16.4	16.5
Calcium (%)	0.79	0.79	0.77
Available P (%)	0.3	0.3	0.3
ME/CP	176.8	177.4	176.6
Ca/P	2.6	2.6	2.6

1Vitamin content of diets provided per kilogram of diet: vitamin A, D, E and K.2 Composition of mineral premix provided as follows per kilogram of premix: Mn, 120,000mg; Zn, 80,000 mg; Fe, 90,000 mg; Cu, 15,000 mg; I, 1,600 mg; Se, 500 mg; Co, 600 mg.3 T1 = 0%. 3 T1 = 0 % canola oil (CO); T2 = 2%CO; T3 = 4% CO

Table 4: Least square means for fatty acid profiles in broilers breast meat fed canola oil

	Treatments				
	T1	T2	T3	SEM	P>F
C14:0	0.59^{a}	0.51^{a}	0.54^{a}	0.016883	0.1101
C14:1n5	0.11^{b}	0.10^{b}	0.54^{a}	0.009156	<0.0001
C16:0	28.50^{a}	27.01^{a}	22.71^{b}	0.765465	0.0262
C16:1n7	6.47^{a}	6.60^{a}	5.26^{b}	0.176499	0.0218
C18:0	6.60^{a}	6.21^{a}	6.34^{a}	0.18724	0.4380
C18:1n9	33.65^{a}	30.00^{a}	30.81^{a}	0.920539	0.1299
C18:1n7	2.40^{b}	2.93^{a}	2.73^{ab}	0.078816	0.0379
C18:2n6cis	15.35^{a}	13.53^{ab}	12.33^{b}	0.404577	0.0295
C18:3n3	0.72b	0.75b	0.87a	0.02186	0.0295
C20:0	0.75a	0.24b	0.23b	0.013268	0.0002
C20:5n3	0.37c	1.18b	2.03a	0.040638	0.0002
C20:1n9	0.17c	0.23b	0.31a	0.007092	0.002
C22:6n3	0.61b	0.62b	0.75a	0.01854	0.0228
C22:0	0.93b	1.96a	1.93a	0.050233	0.0011

[a-c] Values in the same row with no common superscripts are significantly different

In order to reduce variation in the cutting procedure, all dissections were carried out by one operator. After weighing the eviscerated carcass, it was apportioned into commercial cuts as back, 2 leg-thigh, 2 wings and breast (Hudspeth *et al*., 1973; Orr *et al*., 1984). Breast was obtained after removing wings by cutting through the shoulder joint at the proximal end of humerus and by cutting through the ribs, thereby separating the breast from the back (excluding skin). The resulting cut pieces (breast meat, wings and thighs with drumsticks) were then weighed. After quartering, breasts and thighs were

Table 5: Least square means for fatty acid profiles in broilers thigh meat fed canola oil

	Treatments				
	T1	T2	T3	SEM	p>F
C14:0	0.60[a]	0.14[c]	0.17[b]	0.0122	0.0002
C14:1n5	0.195[c]	0.87[a]	0.47[b]	0.0171	0.0002
C16:0	26.21[a]	22.37[b]	21.88[b]	0.6878	0.0370
C16:1n7	6.20[b]	7.83[a]	6.17[b]	0.1973	0.0149
C18:0	8.280[b]	8.96[ab]	10.07[a]	0.2667	0.0393
C18:1n9	35.32[a]	37.25[a]	35.76[a]	1.0534	0.4686
C18:1n7	2.52[a]	2.48[a]	2.27[a]	0.0703	0.1453
C18:2n6cis	13.14[a]	11.53[b]	12.0[ab]	0.3565	0.1002
C18:3n3	0.52b	0.66a	0.74a	0.0185	0.0085
C20:0	0.81a	0.54c	0.63b	0.0185	0.0041
C20:5n3	0.34c	1.43b	2.36a	0.0461	0.0002
C20:1n9	0.12b	0.21a	0.14b	0.0041	0.0013
C22:6n3	0.25b	0.50a	0.57a	0.0126	0.0016
C22:0	0.76b	1.94a	1.96a	0.04656	0.0005

[a-c] Values in the same row with no common superscripts are significantly different

Table 6: Least square means for different traits in broilers breast meat fed canola oil

Treatments	T1	T2	T3	SEM	p>F
Satur F.A	37.37[a]	35.94[ab]	31.76[b]	0.969	0.0534
MUFA	42.80[a]	39.87[a]	39.65[a]	0.807	0.1166
PUFA	16.33[a]	15.33[a]	15.11[a]	0.390	0.2061
Total n-6	15.35[a]	13.53[b]	12.33[b]	0.403	0.0292
Total n-3	1.70[c]	2.55[b]	3.66[a]	0.043	0.0002

[a-c] Values in the same row with no common superscripts are significantly different

Table 7: Least square means for different traits in broilers thigh meat fed canola oil

Treatments	T1	T2	T3	SEM	p>F
Satur F.A	36.65[a]	33.94[a]	34.73[a]	0.97	0.2709
MUFA	44.28[b]	48.62[a]	44.79[ab]	0.91	0.0761
PUFA	13.74[a]	13.45[a]	14.81[a]	0.33	0.1163
Total n-6	13.14[a]	11.52[b]	12.00[ab]	0.36	0.1008
Total n-3	1.12[c]	2.58[b]	3.56[a]	0.053	0.0001

[a-c] Values in the same row with no common superscripts are significantly different

separated and frozen at -20°C until to determine as fatty acids profile. The lipid composition was determined by gas chromatography (Model 6890N American Technologies Agilent). The composition of meat samples fatty acid of supplemented lipids is shown in Table 4-7 data were statistically analyzed using one-way ANOVA and means with significant F ratio were compared by Duncan multiple range test.

GAS CHROMATOGRAPHY OF FATTY ACIDS METHYL ESTERS

Sample preparation

Fatty acids: Total lipid was extracted from breast and thigh according to the method of Folch *et al.* (1957). Approximately 0.5 g of meat weighed into a test tube with 20 mL of (chloroform: Methanol = 2:1, vol/vol) and homogenized with a polytroon for 5-10 s at high speed. The BHA dissolved in 98% ethanol added prior to homogenization. The homogenate filtered through a Whatman filter paper into a 100 mL graduated cylinder and 5 mL of 0.88% sodium chloride solution added, stopper and mixed. After phase separation, the volume of lipid layer recorded and the top layer completely siphoned off. The total lipids converted to Fatty Acid Methyl Esters (FAME) using a mixture of boron-trifluoride, hexane and methanol (35:20:45, vol/vol/vol). The FAME separated and quantified by an automated gas chromatography equipped with auto sampler and flame ionization detectors, using a 30 m´ 0.25 mm inside diameter fused silica capillary column, as described. A (Model 6890N American Technologies Agilent) (U.S.A) Gas chromatography used to integrate peak areas. The calibration and identification of fatty acid peak carried out by comparison with retention times of known authentic standards. The fatty acid results form gas chromatography with Chem Station software analyzed and expressed as weight percentages.

Statistical analyses: Data were analyzed in a complete randomized design using the GLM procedure of SAS version 12 (SAS Inst. Inc., Cary, NC).

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$$

Where:

y_{ij} = All dependent variable
μ = Overall mean
α_i = The fixed effect of oil levels (i = 1, 2, 3)
ε_{ij} = The random effect of residual

Duncan multiple range test used to compare means.

RESULTS AND DISCUSSION

Result shows that with usage unsaturated oil (Canola oil) in experimental diet the level of saturated fatty acid in breast meat include myristic (C14:0), palmitoic (C16:1n7), stearic (C18:0), arachidic (C20:0) and docosanoic (C22:0) acids numerically decreased and from 37.37% for treatment without oil significantly ($p<0.05$) reached to 35.94 and 31.76%, respectively for T2 and T3 but for thigh meat this fatty acid content a little changed and for treatment T1 with 0% (CO) 36.65 reached to 33.94 and 34.73 for T2 and T3 but not significant. According to results Saturated Fatty Acids (SFA) for breast meat is significant ($p<0.05$) and from 37.37% reached to 35.94 and 31.76% for T2 and T3, respectively and for thigh meat not significantly difference but numerically decrease and from 36.65% for T1 (0% CO) reached to 33.94 and 34.73%, respectively for T2 and T3.

A significant difference ($p<0.05$) finding was the effect canola oil on the myristic acid content of thigh meat and no significant for breast meat. This condition show that usage canola oil could greater affected (C14:0) thigh meat until breast meat and for palmitic acid content show that for 2 part of meats significantly ($p<0.05$) affected this fatty acid content. The lack of a significant difference ($p<0.05$) among diet with different levels of canola oil for myristic acid content in breast meat, indicated decrease conversion efficiency with increased level of canola oil in the diet. Palmitic acid content from 28.50% in T1 (0% CO) reached to 27.01 and 22.71%, respectively for T2 and T3. The arachidic acid content were significantly ($p<0.05$) between treatment for both two part of meat. Thus the significantly ($p<0.05$) lower percentage of myristic and palmitic content found in the thigh meat compared with breast meat. The canola oil affected not only the quantity of fatty acids but also the alter content of the saturated fatty acid in the both type of tissues. As the percentage of canola oil increased, the fatty acid profile improved as evidenced by the change in the relationship of the palmitic and stearic contents. The decrease in total saturated fatty acids contents were due primarily to the decrease in palmitic fatty acid, because stearic acid is considered much less hypercholestrolemic, or not hypercholeterolmic compared to palmitic fatty acid (Bonanome and Grundy, 1988; Nelson, 1992; Katan *et al*., 1995; Grundy, 1997), addition of canola oil to the diet was clearly beneficial. Dietary saturated fatty acids are an independent risk factor associated with coronary heart disease; their negative effects on low density lipoprotein cholesterol (America Heart Association, 1988; Hornstra *et al*., 1998). The reeducation in palmitic acid (up to 5 and 4% for breast and thigh meat, respectively) in the diets with canola oil could indicate a strong health advantage for these meats. The decrease saturated fatty acid contents in thigh meat found as omega-3 PUFA increased (Ayerza and Coates, 2000). As suggested in this study, the decrease in oleic and palmitic acids in breast meat could be related to the inhibition effect of PUFA against Δ9-desaturase activity, preventing the formation of MUFA from their precursors. Δ9-Desaturase in the keyenzyme needed to convert palmitic to palmitoleic acid and stearic to oleic acid (Bernner, 1974). This interaction between MUFA and PUFA has been reported in other animals as well (Brenner, 1974; Garg *et al*., 1988). α-linolenic acid of the thigh and breast meat was significantly ($p<0.05$) affected by the usage canola oil in experimental diets. The 4% canola oil produced a significantly ($p<0.05$) higher linoleic content in the thigh and breast meat than the control diet. Canola oil dramatically increased the omega-3 α-linolenic acid content of both tissues. Deposition in breast meat greater than thigh meat and reaching to 0.87 and 0.74%, respectively with 4% canola oil. The different α-linolenic acid deposition patterns observed for the 2 meat tissue agree with the results of others who fed menhaden-oil enriched diets (Cherian *et al*., 1996; Miller *et al*., 1969), red fish meal (Hulan *et al*., 1988, 1989; Ratanayake *et al*., 1989), red fish oil (Hulan *et al*., 1988) and an unknown fish oil (Lopez- ferrer *et al*., 1999a).

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